FLORISTIC COMPARISON OF THREE BIRD ISLANDS IN THE GULF OF MAINE*

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The influence of birds on the flora of islands is of major interest to biogeographers. Birds are reported to carry propagules for great distances. Cruden (1966) discussing the findings of Darwin, Kerner, Guppy and Willis states, "on the basis of numerous examples which these observers give, there is little doubt that birds act as dispersal agents". There is, thus, some reason to suppose that islands far from land may become populated to a considerable degree by plants whose reproductive structures were transported by birds. Certain islands also support enormous concentrations of sea birds which react with their limited environment in many ways to facilitate or inhibit plant growth. By carefully documenting the flora of three bird islands in the Gulf of Maine, we hope to cast some light on the matter of dispersal of plants to bird islands and on the selective effects birds have on the flora. The three islands to be compared are Machias Seal Island off the coast of Eastern Maine, Matinicus Rock offshore of Matinicus Island in the Gulf of Maine, and Gull Rock, one of the Wolf Islands in New Brunswick in the Bay of Fundy.

Some years ago we published an account of the vascular plants of Machias Seal Island (1962) emphasizing the instability of the flora as indicated by changes in the kinds and abundance of plants recorded at three different times, 1947-48 by Hawksley, 1960 by Pike, and again in 1962 by Pike and two experienced assistants.

So far as we can determine the literature on the plants of bird islands in Northeastern America is sparse or else

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buried in the ornithological literature. One paper which relates somewhat to our work is by Smith and Schofield (1959). They observed and collected the vascular flora of Ciboux and Hertford Islands off the east coast of Cape Breton in Victoria County, Nova Scotia. Hertford Island of 27 acres lies about one and one-half miles east of the mainland of Cape Breton while Ciboux of 35 acres is out another half mile. These two islands are much closer to the mainland than the three bird islands discussed in this paper and presumably have become invaded by heavy bird populations in recent time, indicated in part by the presence of several living woody species of trees and shrubs and by evidences of earlier forest conditions. The fact that woody species were diminishing on these islands is in line with our observations.

Considerable work on bird islands has been carried out in Great Britain admirably summarized with many references by Darling and Boyd (1964). North Rona, an island of 300 acres reaching a height of 355 feet and lying some 45 miles from the mainland, resembles our bird islands in some ways. In several visits of botanists no woody species have been recorded and, at each visit, some new species appeared and others were absent. The first botanical record made gave 35 species; on the next visit 4 of these were missing but 12 new ones appeared. Again a few years later 8 of those recorded earlier could not be found but 4 new ones appeared. This fluctuating record is somewhat similar to our findings on Machias Seal Island (1962).

A repeat visit to Machias Seal Island was planned to follow after an interval of several years to discover what further changes might have taken place. The earliest convenient time, when weather and other circumstances allowed, was on August 8, 1967, after a month or more of almost continuous fog. No striking changes were noted in 1967 compared with the 1962 observations and list. It should be kept in mind that the records made by Hawksley in the years 1947 and 1948 reflected, by his own account, the pressure of heavy grazing and much interference with

nature. The establishment of Machias Seal Island as a bird sanctuary with consequent protection of its plant life must have helped to stabilize its vegetation. The few additional species that we found for the first time in 1967 are so indicated in the accompanying list. Some of these probably were overlooked in September 1960 and 1962 because of the exceedingly lush growth of overtopping asters in those years. At the time of our visit in early August 1967, the asters were still in an early stage of growth.

The next logical step involved making a comparison of Machias Seal with other islands having somewhat similar environmental parameters. Matinicus rock, far out to sea south of Rockland, Maine, and several miles farther out than Matinicus Island itself, came immediately to mind. Both Machias Seal and Matinicus Rock which are of approximately the same size, ten to twelve acres, have had a long recorded history of occupancy by puffins, razor-billed auks and arctic terns. Both also have supported lighthouses but, being treacherous of access, have repelled human visitors except students of birds. In early 1966 we had received permission from Dr. & Mrs. Buckheister and the National Audubon Society to visit Matinicus Rock at a time of year when there would be no disturbance to nesting birds, but it was not until September 2, 1967, that we succeeded in getting there. Storms in 1966 and almost continuous fog in the summer of 1967 made it more difficult to reach Matinicus Rock than any of the many other islands we have visited during our eight years of botanizing in the Bay of Fundy and Gulf of Maine. Our visit in early September proved to be very difficult; strong, cold winds and rough water, as well as some fog and rain, permitted us only about one and one-half hours ashore to make collections, record observations, and make a photographic reconnaissance.

Matinicus Rock is aptly named, the island is chiefly exposed granite and, unlike Machias Seal Island which has extensive "meadows" of asters, umbellifers, docks, grasses, sedges, sorrel, etc., the "Rock" has only continuous ledge with many interrupted limited patches of vegetation. Both

islands have some pools, those on Matinicus Rock being much more numerous and thus accounting perhaps for the presence there of two species of *Scirpus*. On the other hand, *Callitriche*, an ideal pool inhabitant, was present on Machias Seal Island but absent from the "Rock" indicating that, after all, chance must play an important role in the migration of plants to these islands. Certainly such pools of varied extent, some of them toward the highest parts of Matinicus Rock, would be excellent habitats for many kinds of aquatic or paludal plants.

During our brief stay, it was possible to visit all obvious habitats and nearly all of the separate patches of vegetation. A total of 64 species was collected, this being a larger number than was taken at any one visit to Machias Seal Island. Considering the much larger area in vegetation on Machias Seal, we could accept this list as being reasonably complete for the year 1967 but, knowing the inadequacies of single collecting visits made under even the best of conditions, we must be frank to state that undoubtedly there are some species on Matinicus Rock yet to be discovered.

Gull Rock is different in several respects from the other two bird islands. It lies closer to other bits of land, being less than a half mile from the nearest of the other Wolves; it is much smaller and rises more precipitately on all sides from the sea thus affording less opportunity for supralittoral plants to grow and it supports gull populations instead of tern-auk-puffin societies of Machias Seal and Matinicus Rock. However, it shares certain characteristic features with the others. All three are far from the mainland, Machias Seal 11 miles, Matinicus Rock 19 miles, and Gull Rock 8 miles. There is, at the present time, little direct human interference with vegetation on any one of the three and no species of woody plant is found on any of them.

While there is no close positive correlation in general of size of island and diversity of habitats, the islands under consideration do show such a correlation, Gull Rock, the smallest, having certainly fewer kinds of niches for vascu-

lar plants. This presumably is reflected in the presence of only 34 species of vascular plants there.

The influence of birds on these island floras is shown in many ways. All woody plants are excluded, embracing entire families or major taxonomic groupings, eg. Gymnospermae, Salicaceae, Myricaceae, Corylaceae, Saxifragaceae, Empetraceae, Aquifoliaceae, Aceraceae, Ericaceae and Caprifoliaceae. Other major groups absent are Equisetaceae, Lycopodiaceae and Polypodiaceae, the only fern noted being the cinnamon fern, *Osmunda cinnamomea* on one island. No Orchidaceae were present while the following families were each represented sparsely on one island only by a single species: Liliaceae, Violaceae, Onagraceae and Labiatae. The above groups are all well represented on non-bird islands in the Gulf of Maine, sometimes in the immediate vicinity as in the Wolf Island group. It is evidently the environment created by the birds en masse that inhibits the growth of these species.

The Wolf Islands other than Gull Rock are forested except for limited clearings and bird lawns although some forested portions in areas adjacent to bird lawns have been invaded by birds. Where concentrations of gulls are heavy, the conifers in particular are killed, but there seems to be stimulation of growth in many other groups. For example, in these situations we have noted an increase in growth in *Rubus idaeus*, *Ribes lacustre*, *R. hirtellum*, *R. glandulosum*, several species of *Solidago* and *Aster*, *Achillea Millefolium*, *Iris versicolor*, *Ligusticum scothicum*, *Conioselinum chinense*, *Streptopus* spp. *Dryopteris spinulosa* var. *americana* and some other species. It seemed to us that the mere release of these plants from the overstory of conifers would hardly have accounted for such lush development. Apparently up to a high level of fertility, many woody plants and various other kinds as well are stimulated but beyond this level toxicity results. It might also happen that direct contact of plants and birds in such cases serves to destroy the plants. Experimental work is needed to show in what way

the environment inhibits the germination and or subsequent development of many kinds of plants.

The conclusion seems warranted that the environment provided by nesting birds on small islands in the Gulf of Maine serve initially to screen out and eliminate a considerable percentage of potential migrant plants or of plants already present and to select the majority of its species from relatively few taxonomic groups.

It follows that certain families of plants will be strongly represented; the Gramineae account for 16 out of the total of 114 species on the three islands. The Polygonaceae include 8, Caryophyllaceae 8, Leguminosae 7 and the Compositae 19. Thus, these 5 families comprise a bit over 50% of the total bird island flora. This contrasts markedly with the same families comprising 28.5% of the total Wolf Island vascular flora.

Three categories may be made of the bird island plants, first the species that occur on all three islands, second those on two and finally those found only on one. Twenty-one species are common to all the islands. These are generally of common occurrence in the region with no particular adaptation for the bird islands as is shown by the presence of all of them in considerable abundance on the non bird island members of the Wolf Island group as well as their frequency of occurrence elsewhere in the coastal areas nearby. This group of species is well adapted to the climatic and edaphic conditions of the region and also posseses effective means of dispersal.

The list of species that are present on any two of the three bird islands but are lacking from the third includes only 18 species. Thirteen species are shared by Machias Seal Island and Matinicus Rock and are absent from Gull Rock. Two of this group, *Juncus bufonius* and *Plantago juncoides* are of very general distribution in the area and their absence from Gull Rock or at least the fact that we didn't find them there is attributable to the fact that Gull Rock has a very abrupt rocky shore providing few or no suitable habitats for either species. The other 11 species

of the group absent from Gull Rock are in general somewhat less widely distributed on the other Wolf Islands than those species of the first group and their absence perhaps may be accounted for also by the scarcity of suitable habitats. Four species are found on Machias Seal and Gull Rock but are absent from Matinicus Rock while only one species, *Lathyrus japonicus*, occurs on Gull Rock and Matinicus Rock only.

The remaining 75 species or nearly 66% of the bird island flora are present on only one of the three bird islands. Many of these casual species are weeds which in all probability were brought to the islands by man during his occupation of Machias Seal and Matinicus Rock where the majority of these are found. Many weeds have propagules which undobutedly may be carried far by air currents, water or birds. It is to be noted however that *Ambrosia artemisiifolia* which is absent from two of the bird islands, being found only on Matinicus Rock, is absent also from all of the Wolf Island group. Several years ago we paid a brief visit to another bird island known as White Horse Island, a Cormorant rookery and the nearest land to the Wolves. One of the dominant weeds there was *Ambrosia artemisiifolia* growing with huge nettles (*Urtica* sp.) making a most disagreeable tangle virtually covering the entire island. Both species are absent from Gull Rock though we have observed nettles on three of the other Wolf Islands. Human visitors on White Horse Island must be more frequent than on Gull Rock since the former is only a mile or two away from Campobello Island and the mainland of New Brunswick. Also it is much more likely that bird visitors from the settled islands and mainland could have introduced propagules more often on White Horse Island than on the Wolves because of the shorter distance to travel.

Several species seem to be of chiefly fortuitous occurrence on the three bird islands such as *Callitriche heterophylla*, *Arenaria lateriflora* and *Galium tinctorium* on Machias Seal Island and *Ranunculus Cymbalaria*, *Convolvulus sepium* and *Mertensia maritima* on Matinicus Rock. The

habitats for these native species as well as for most of the introduced weeds would seem to be about equally favorable on both Machias Seal and Matinicus Rock.

It is evident also that many of the records of plants found on only one island relate in some way to the proximity of that island to other land masses nearby, for example Gull Rock to the other Wolf Islands, Machias Seal to Grand Manan and the Coast of Maine and Matinicus Rock to Monhegan Island and Matinicus Island.

The conclusion seems tenable that these bird islands, following the initial screening out or elimination of many kinds of plants including all woody plants, become populated to a great extent by introduced weeds or by those native species that occur abundantly on the nearest bodies of land. This is not to rule out the probability that part of the bird island flora is residual, having occupied these islands from early post glacial times or at least from some time previous to their domination by birds. It would appear that man has introduced many species of plants to suitable habitats on these islands. The evidence seems to show also that occasionally as with *Callitriche* on Machias Seal Island, birds may well be agents of wide dispersal. It should be kept in mind that puffins, razor-billed auks and arctic terns, which spend their time at sea except when nesting, are not likely candidates for effective transport of plant propagules. Herring gulls on the other hand are in part markedly terrestrial and theoretically should be effective as agents of dispersal. The failure to find strong correlation of floras on the several islands and the frequent absence of potentially adapted species such as *Ambrosia artemisiifolia* which often are abundant a few miles or less away from an island, suggest to us that dispersal over miles of open ocean to bird islands is not frequently accomplished. Our study indicates that the screening effect of bird populations on bird island floras is more apparent than their transport of propagules.

Herbarium specimens from the three bird islands dis-

cussed are deposited in the Herbarium of the University of New Hampshire (NHA).

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COMPARATIVE LIST OF FLORAS ON THREE BIRD ISLANDS

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
1. *Osmunda cinnamomea* L.	X		
2. *Festuca rubra* L. var. *rubra*	X	X	X
3. *Puccinellia laurentiana* Fern. & Weath.			X
4. *P. paupercula* (Holm) Fern. & Weath. var. *alaskana* (Scribn. & Merr.) Fern. & Weath.	X	X	X
5. *Poa annua* L.	X	X	X
6. *P. compressa* L.			X
7. *P. pratensis* L.	X (1967)		
8. *P. palustris* L.	X (1967)		
9. *Agropyron repens* (L.) Beauv.	X	X	X
10. *Hordeum jubatum* L.		X	
11. *Elymus arenarius* L. var. *villosus* Mey.	X	X	X
12. *Elymus virginicus* L.		X	
13. *Deschampsia flexuosa* (L.) Trin.			X
14. *Calamagrostis canadensis* (Michx.) Nutt.	X		X
15. *Agrostis alba* L. var. *alba*	X		
A. alba var. *palustris* (Huds.) Pers.	X	X	X
16. *Phleum pratense* L.	X	X	
17. *Anthoxanthum odoratum* L.	X (1967)		
18. *Scripus validus* Vahl. var. *creber* Fern.		X	
19. *Scirpus paludosus* Nels. var. *atlanticus* Fern.		X	
20. *Carex canescens* L. var. *canescens*	X		

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
21. *C. brunnescens* (Pers). Poir. var. *sphaerostachya* (Tuckerm.) Kukenth.	X (1967)		
22. *C. scoparia* Schkuhr	X		
23. *C. silicea* Olney	X		
24. *C. hormathodes* Fern.	X	X	
25. *C. paleacea* Wahlenb.	X		
26. *C. crinita* Lam. var. *crinita*			X
27. *Juncus bufonius* L.	X	X	
J. bufonius var. *halophilus* Buchenau & Fern.	X		
28. *Smilacina stellata* (L.) Desf.			X
29. *Sisyrinchium montanum* Greene	X		
30. *Iris versicolor* L.	X	X	X
31. *Urtica gracilis* Ait.		X	
32. *U. viridis* Rydb.	X		
33. *Rumex pallidus* Bigel.	X	X	
34. *Rumex domesticus* Hartm.		X	
35. *R. orbiculatus* Gray	X		
36. *R. crispus* L.	X	X	
37. *R. Acetosella* L.	X	X	X
38. *Polygonum aviculare* L.	X	X	X
39. *P. Persicaria* L.		X	
40. *P. Convolvulus* L.		X	
41. *Chenopodium album* L.		X	
42. *Atriplex patula* L.	X	X	X
43. *A. glabriuscula* Edmondst.	X	X	

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
44. *Suaeda americana* (Pers.) Fern		X	
45. *S. Richii* Fern.		X	
46. *Spergularia marina* (L.) Griseb. var. *leiosperma* (Kindb.) Gurke	X	X	X
47. *S. canadensis* (Pers.) Don		X	
48. *Sagina procumbens* L.	X (1967)	X	
49. *Arenaria lateriflora* L.	X		
50. *Stellaria media* (L.) Cyrillo	X	X	X
51. *S. graminea* L.	X		
52. *Cerastium arvense* L.		X	
53. *C. vulgatum* L.	X	X	X
54. *Ranunculus Cymbalaria* Pursh		X	
55. *R. repens* L. var. *villosus* Lamotte	X		
56. *R. acris* L.	X		
57. *Thalictrum polygamum* Muhl.	X		X
58. *Capsella Bursa-pastoris* (L.) Medic.	X		
59. *Cakile edentula* (Bigel.) Hook.		X	
60. *Raphanus Raphanistrum* L.		X	
61. *Brassica juncea* (L.) Coss.		X	
62. *Sedum Rosea* (L.) Scop.	X	X	X
63. *Potentilla norvegica* L.	X	X	X
64. *P. anserina* L.	X	X	
65. *P. Egedei* Wormsk. var. *groenlandica* (Tratt.) Polunin	X		
66. *Rubus idaeus* L. var. *strigosus* (Michx.) Maxim.			X

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
67. *Trifolium pratense* L.	X		
68. *T. repens* L.	X	X	X
69. *T. hybridum* L.	X		
70. *Vicia angustifolia* Reichard	X		
71. *V. Cracca* L.	X		
72. *Lathyrus japonicus* L.		X	X
73. *L. palustris* L.	X		
74. *Callitriche heterophylla* Pursh	X		
75. *Impatiens capensis* Meerb.	X	X	X
76. *Viola Mackloskii* Lloyd subsp. *pallens* (Banks) Baker	X		
77. *Epilobium glandulosum* Lehm. var. *adenocaulon* (Haussk.) Fern.		X	
78. *Carum carvi* L.	X		
79. *Ligusticum scothicum* L.	X	X	X
80. *Coelopleurum lucidum* (L.) Fern.	X	X	X
81. *Glaux maritima* L.	Seen (1967)		
82. *Convolvulus sepium* L. var. *sepium*		X	
83. *Mertensia maritima* (L.) S.F. Gray		X	
84. *Lycopus uniflorus* Michx.	X		
85. *Solanum Dulcamara* L.		X	
86. *S. nigrum* L.		X	
87. *Euphrasia Randii* Robins.	X		
88. *E. canadensis* Townsend	X		
89. *E. americana* Wettst.	X		

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
90. *Rhinanthus Crista-galli* L.	X		
91. *Plantago major* L.	X	X	
92. *P. juncoides* Lam. var. *decipiens* (Barneoud) Fern.	X	X	
93. *P. oliganthos* R.&S.		X	
94. *Galium Aparine* L.		X	
95. *G. tinctorium* L.	X		
96. *Solidago rugosa* Ait. var. *villosa* (Pursh) Fern.			X
97. *S. sempervirens* L.		X	
98. *Aster foliaceus* L. (Complex)	X	X	X
99. *A. novi-belgii* L.			X
100. *A. johannensis* Fern.	X		
101. *A. umbellatus* Mill.	X		X
102. *Gnaphalium uliginosum* L.	X		
103. *Ambrosia artemisiifolia* L.		X	
104. *Bidens frondosa* L.		X	
105. *Achillea borealis* Bong.	X		X
106. *A. lanulosa* Nutt.	X	X	
107. *A. Millefolium* L.		X	
108. *Matricaria matricarioides* (Less.) Porter	X	X	X
109. *Cirsium arvense* (L.) Scop.	X	X	
110. *Leontodon autumnalis* L.	X		
111. *Taraxacum erythrospermum* Andrz.	X		
112. *T. officinale* Weber	X	X	
113. *Sonchus oleraceus* L.		X	
114. *S. asper* (L.) Hill	X		